

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Tsujimichi, et al.
Serial No.: 10/625,272
Filed: July 23, 2003
Art Unit: 1793
Examiner: Edward M. Johnson
Confirmation No.: 8414
Title: **PHOTOCATALYTIC HYDROPHILIFIABLE MATERIAL**

APPEAL BRIEF

Board of Patent Appeals and Interferences
United States Patent & Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In connection with the subject application, and further to the Notice of Appeal dated 29 October 2008 appealing the Examiner's final rejections of claims 53-67 under 35 USC 102(e), 103(a) and as set forth in the Office Action dated 30 May 2008, and to the Notice of Panel Decision From Pre-Appeal Brief Review dated 10 December 2008, please enter this Appeal Brief pursuant to 37 CFR 41.37.

REAL PARTY IN INTEREST

The real party in interest is the owner/assignee of the application, which is Toto Ltd.

RELATED APPEALS AND INTERFERENCES

None.

STATUS OF CLAIMS

Claims 1-67 are all of the claims which have ever been in the application, of which claims 1-52 have been canceled, while claims 53-67 remain pending in the application and are

directed to a specie of the invention which was elected by applicant in response to a restriction requirement imposed by the PTO. Of those remaining, claim 53 is independent. In the final Office Action dated 30 May 2008, claims 53, 54, 56-58, 60, 66, and 67 are rejected under 35 USC 102(e) as being anticipated by or, in the alternative, under 35 USC 103(a) as obvious over Komatsu et al. (US 5,854,708), and claims 55, 59, and 61-65 are rejected under 35 USC 103(a) as unpatentable over Komatsu. Appellant appeals all of such rejections. A copy of claims 53-67 on appeal is attached hereto as a Claims Appendix.

STATUS OF AMENDMENTS

Appellant submitted an Amendment Under 37 CFR 1.116 dated 29 July 2008 subsequent to the final Office Action of 30 May 2008, but such Amendment was not entered as discussed in an Advisory Action dated 15 August 2008. Previously appellant has submitted: a Preliminary Amendment dated 23 July 2003, an Amendment dated 20 December 2006, an Amendment dated 23 April 2007, and an Amendment dated 20 February 2008, all of which have been entered into the application file record.

SUMMARY OF CLAIMED SUBJECT MATTER

The present invention pertains to a method for cleaning air using a photocatalytic hydrophilifiable material which achieves an improved effectiveness in removing contaminants such as nitrogen oxides (NO_x) from the air by improving the efficiency of the photocatalytic reaction such that a larger percentage of the contaminants are fully chemically reacted to inoffensive products. For effecting the invention, a composite material including a substrate and a single surface layer which is hydrophilic and self-cleanable is provided such that the surface layer is exposed to light and contacted with water and air (so as to promote reaction of the contaminants in the air), wherein the surface layer includes a photocatalyst combined with two other materials so that all of these components are in close proximity to each other within the layer and these other two materials can enhance the function of the photocatalyst. See, for example, ¶¶ [002], [006] – [009], [027], [028], [053], [0134], [0171], and [0178] of the published application 2004/0072684 A1.

Independent Claim 53. Claim 53 on appeal defines: A method for cleaning air, comprising the

steps of:

contacting air with the surface of a composite material which is exposed to light; and
contacting the surface of the composite material with water, said composite material comprising at least a substrate and a surface layer, said surface layer being hydrophilic and self-cleanable, said surface layer comprising three components comprising:

a component (i) comprising a photocatalyst which functions as a catalyst upon exposure to light;

a component (ii) comprising at least one metal oxide selected from the group consisting of Al_2O_3 , ZnO , SrO , BaO , MgO , CaO , Rb_2O , Na_2O , K_2O , and P_2O_5 ; and

a component (iii) comprising at least one metal oxide selected from the group consisting of SiO_2 , ZrO_2 , GeO_2 , and ThO_2 ;

wherein components (i), (ii) and (iii) are all situated within said surface layer which is provided as a single surface layer, such that all of said components are in close proximity to one another within the single surface layer.

While the drawings of the present application do not identify the substrate and surface layer of the claimed composite material with reference numbers in the drawings, it is explained that: the substrate may be formed of many different materials such as glasses, ceramics, metals and resins, etc. (see, for example, ¶¶ [0052], [0053], [0171] of the published application); the photocatalyst may be titanium dioxide (TiO_2); and in Figs. 1(a) – 1(c) a surface layer including TiO_2 photocatalyst and Al_2O_3 as the component (ii) is depicted (on a molecular scale) reacting NO (nitrous oxide) to nitrogen dioxide (NO_2) in a first reaction, and then to nitric acid (NO_3^-).

Advantages. Such method according to the invention is very advantageous because the single surface layer of the composite material, which includes the metal oxides (ii) and (iii) together with the photocatalyst (i) all in close proximity there within, significantly enhances the ability of the photocatalyst to promote chemical reactions of contaminants contained in the air, when exposed to light and water, so that the contaminants are fully chemically reacted into inoffensive products. See

paragraphs [007], [008], [0066] – [0079] of the original specification. See, for example, ¶¶ [002], [006] – [009], [027], [028], [053], [0134]-[151], [0171], [0178], [0221], and [0247]-[0257] of the published application, as well as Table 5, example 5, example 7 of Tables 3, 4, and Figs. 1-7, 17, 22. More specifically, as explained at ¶¶ [0134]-[151] in conjunction with Figs. 1-7 and example 5 of Table 1, the disposition of a metal oxide component (ii) such as Al_2O_3 closely together with the photocatalyst such as TiO_2 in the surface layer permits the photocatalyst to achieve a significantly enhanced effectiveness in removing contaminants such as NO_x , SO_2 , and CO_2 from the air as compared to a surface layer not containing a metal oxide such as component (ii) disposed closely together with the photocatalyst; while as explained at ¶¶ [0221], and [0247]-[0257] of the published application, in conjunction with Table 5, the further addition of a metal oxide corresponding to the component (iii) closely together with the photocatalyst and the metal oxide component (ii) in the single surface layer significantly improves hydrophilicity of the surface layer and this provides a synergistic advantage as discussed at ¶ [0255] of the published application:

“Possessing both the hydrophilic nature and the decomposition activity has the following advantages. Specifically, a two-stage process of removal of stains based on the hydrophilic nature and removal of stains based on the decomposition activity can provide markedly improved removal of deposited stains and improved removing speed. In this case, for some stains, the deposition strength of slight stains left after the removal of stains based on the hydrophilic nature is high. However, the improved decomposition activity through the regulation of the amount of the metal supported enables even the slight stains having high deposition strength to be removed. Further, removal of the stain can prevent the photocatalyst from undergoing light shielding. This can increase the quantity of light applied. Therefore, removal of stains based on the hydrophilic nature and removal of stains based on the decomposition activity can be very efficiently retained.”

Background Art Discussed at ¶¶ [003] – [0005] of the Published Application

Photocatalytic hydrophilifiable formulations containing a photocatalyst are finding expanded applications because energy used in catalytic reactions is light energy, such as sunlight, that is inexhaustible. For example, titanium dioxide (TiO_2), a kind of photocatalyst, particularly titanium oxide in an anatase crystal form, produces excited electrons and positive holes upon exposure to light energy (ultraviolet light), and the excited electrons and positive holes produce active oxygen species, such as O_2^- , O^\cdot , and $\bullet\text{OH}$ (wherein the \bullet represents an unpaired electron and means that the species attended with the \bullet is a free radical), in the presence of oxygen and water on the surface of the catalyst. Applications utilizing free radical

properties of the active oxygen species have been proposed such as air purification applications where nitrogen oxides (NO_x) in the air are oxidized with the active oxygen species and consequently converted to a harmless reaction product (nitric acid), and degradation of bacteria through the oxidation of organic matter, that is, the so called antimicrobial applications.

In the course of the oxidation of the nitrogen oxides with the active oxygen species, nitrogen dioxide (NO_2) is produced as an intermediate that is further oxidized and finally converted to nitric acid. As a result of the production of nitric acid, the nitrogen oxides in the air are reduced, and the air is purified. For this reason, the presence of the active oxygen species and the nitrogen oxide or nitrogen dioxide is indispensable for enhancing the percentage reduction of nitrogen oxides. Since, however, nitrogen dioxide is a relatively chemically stable compound (gas), the produced nitrogen dioxide leaves the reaction system. This lowers the efficiency of the oxidation with the active oxygen species, resulting in lowered percentage reduction of the nitrogen oxides. Use of porous adsorbents, such as activated carbon, is considered effective for preventing nitrogen dioxide from leaving the reaction system. As is apparent from the following description, this method is not always effective.

Specifically, when nitrogen dioxide, which has left, is adsorbed on the above adsorbent, the nitrogen dioxide often remains within pores of the adsorbent without being released. For this reason, in some cases, the adsorbed nitrogen dioxide is placed outside the system of oxidation with the active oxygen species and does not undergo the oxidation reaction and hence cannot be converted to nitric acid as a final product. Thus, the nitrogen oxides are not finally converted to nitric acid. This inhibits the reduction of nitrogen oxides. In this case, it should be noted that nitrogen dioxide adsorbed onto the adsorbent in a region where nitrogen dioxide can be present together with the active oxygen species and is in the reaction system, that is, in a region close to the photocatalyst, is oxidized to produce nitric acid. Since, however, the region close to the photocatalyst occupies only a small proportion of the whole material adsorption region (including pores) in the adsorbent, it can be said that the proportion of nitrogen dioxide, which could not be oxidized to nitric acid, is high. That is, the adsorbent merely adsorbs and holds nitrogen dioxide, and the percentage reduction of nitrogen oxides by conversion to nitric acid does not appear to be satisfactory.

The invention as defined in claims 53 overcomes the discussed problems of the

conventional systems.

Dependent claim 67 further defines that the components (i), (ii) and (iii) are all substantially intimately mixed and dispersed in the single surface layer. See paragraphs [00126] - [0132], [0190], [0196], [0244] of the publication. This close proximity of components (i) – (iii) is believed to provide superior functionality as used in applicant's claimed method, as extensively discussed throughout the original application.

Dependent claim 54 further defines that the composite material satisfies $a/(a+b)$ of about 0.0001 to about 0.8, wherein a represents the weight of the metal oxide as the component (ii) and b represents the weight of the photocatalyst as the component (i). When the value of $a/(a+b)$ is not less than about 0.0001 as specified in the preferred fourth embodiment, the other compound (amphoteric metal oxide, basic metal oxide, or acidic metal oxide) represented by a can advantageously ensure the chemical bond of the reactant or the intermediate to prevent the lowering of the catalytic reaction efficiency. When the value of $a/(a+b)$ is not more than about 0.8, the amount of the photocatalyst represented by b is advantageously not too small in relationship with the other compound, so that lowering of the efficiency of the catalytic reaction can be advantageously avoided. See ¶ [0020].

Dependent claim 55 further defines that the photocatalyst as the component (i) and the metal oxide as the component (ii) are contained in the form of particles having a diameter of about 0.005 to about 0.5 microns. When the particle diameter of the photocatalyst and the particle diameter of the other compound (amphoteric metal oxide, basic metal oxide, or acidic metal oxide) are in the range of from about 0.005 to 0.5 microns, the regulation of the particle diameter can be advantageously carried out by means of an existing grinding device, such as a ball mill, or by the sol-gel process. Further, according to the fifth preferred embodiment, there is no significant difference in particle diameter between the photocatalyst and the other compound, particles of the photocatalyst and particles of the other compound having diameters similar to those of the particles of the photocatalyst approach each other. Therefore, the other reactant or intermediate chemically bonded to the other compound can approach the photocatalyst. This advantageously ensures the opportunity for the catalytic

reaction to proceed, realizing improved efficiency. See ¶ [0022].

Dependent claim 56 further defines that the composite material further comprises a component (iv), in said surface layer, comprising at least one antimicrobial metal selected from the group consisting of zinc, silver, and copper, and wherein the antimicrobial metal as the component (iv) is supported on the photocatalyst as the component (i). This added component (iv) in the single surface layer in close proximity with the components (i) –(iii) advantageously supplements the antimicrobial activity of the surface layer, even in situations where the surface layer may be somewhat shielded from light. See, for example the 4th and 6th examples discussed in ¶¶ [0180] – [0190] and [0195] – [0197] and Figs. 11, 12, and 14 of the publication.

Dependent claim 57 further defines that the surface layer further comprises at least one metal selected from the group consisting of silver, copper, palladium, iron, nickel, chromium, cobalt, platinum, gold, rhodium, and ruthenium. Additionally including such metal(s) in the surface layer advantageously: improves the hydrophilicity of the surface layer for enhanced effectiveness in removing contaminants; improves antimicrobial activity, and the metal can be advantageously supported on titanium dioxide by the reduction potential (supporting by reduction). See the 10th embodiment of the invention as discussed in ¶¶ [0031], [0180], [0181], [0214] of the publication.

Dependent claim 58 further defines that the surface layer further comprises at least one metal selected from the group consisting of lithium, calcium, magnesium, and aluminum in an amount effective for improving the hydrophilicity. Again, such added metal(s) in the surface layer advantageous improve hydrophilicity of the layer as discussed at in ¶¶ [0031], [0181] of the publication.

Dependent claim 59 further defines that the composite material of claim 56 satisfies c/d of about 0.00001 to about 0.05 wherein c represents the weight of the component (iv) and d represents the weight of the photocatalyst as the component (i). When the metal as the fourth component has a c/d value of not less than 0.00001, there is no possibility that the amount of the metal is too small to exhibit synergistic antimicrobial activity, while when the metal as the fourth component has a

c/d value of not more than 0.05, there is no possibility that the amount of the metal is excessive and adversely affects the catalytic reaction of the photocatalyst. See ¶ [0031] of the publication.

Dependent claim 60 further defines that the surface layer has a geometry satisfying any one of the following requirements (1) and (2):

- (1) thickness of the surface layer is about 0.01 to about 3.0 microns; and
- (2) difference in color ΔE of the surface layer between before ultraviolet irradiation and after ultraviolet irradiation of the surface layer, with a 1% silver nitrate solution deposited thereon, for 5 min at an ultraviolet intensity on the surface layer of 1.2 mW/cm^2 , is 1 to 50.

These aspects of the surface layer are particularly advantageous. When the thickness of the surface layer is not less than about 0.01 microns, the layer (surface layer) is not too thin and is advantageous in that the contact angle of the surface layer per se can be surely utilized as the contact angle of the material. Specifically, even though the substrate has a high contact angle, the surface layer provided on the substrate can reduce the contact angle as the material. Therefore, the material can exhibit high antifouling effect. On the other hand, when the thickness of the surface layer is not more than about 3.0 microns, the adhesion of the surface layer to the substrate can be maintained. This can advantageously prevent the separation of the surface layer (layer separation). This is true of the use of the compound as the third component in combination with the metal as the fourth component.

Silver ions in the silver nitrate solution deposited on the surface layer are reduced and precipitated to develop a color, as a result of receipt of excited electrons from the photocatalyst in the excitation upon exposure to ultraviolet light. Therefore, a color difference ΔE is observed between before ultraviolet irradiation and after ultraviolet irradiation of the surface layer. The more excited electrons produced, the larger the color difference ΔE . The amount of the excited electron produced is a factor that governs the photoactivity of the photocatalyst. This enables the photocatalytic activity to be evaluated by using the color difference ΔE . The excited electrons of the photocatalyst produce active oxygen species, such as hydroxy radical, in the air. Therefore, the higher the photocatalytic activity, that is, the larger the color difference ΔE , the greater the amount of the active oxygen species, such as hydroxy radical. See ¶¶ [0042] - [0044] of the publication

Dependent claim 61 further defines that the composite material has a binder which is interposed between the substrate and the surface layer, while Dependent claim 62 further defines that the binder is polymerizable or meltable below a temperature at which the substrate is deformed, to fix the surface layer onto the substrate, and Dependent claim 63 further defines that the binder of claim 62 is a glaze or a paint. Use of such binder is advantageous to avoid rapid melting of the binder can be avoided, preventing unfavorable phenomena, such as excessive embedding of the photocatalyst formulation, the creation of irregular surface, or creation of pinholes, as well as damage to the substrate. See ¶¶ [0069], [0070] of the publication.

Dependent claim 64 further defines that the substrate is a tile, while Dependent claim 65 further defines that the substrate is an earthenware, a wood, a calcium silicate material, concrete, a cement board, a cement extruded board, a plaster board, or an autoclave light-weight concrete board. The ability to use the discussed substrates greatly expands the convenience of the claimed method for cleaning air. See ¶¶ [0171], [0246], [0268] of the publication.

Dependent claim 66 further defines that the composite material has an antimicrobial metal or a metal compound which is anchored on the surface of the surface layer. According to this feature, during exposure to light, the antimicrobial activity of the photocatalyst per se in the surface layer is utilized, while in the absence of light, the antimicrobial activity of the metal or the metal oxide anchored on the surface of the surface layer is utilized. Therefore, the antimicrobial activity of the photocatalyst can be supplemented. See ¶¶ [0055] of the publication.

GROUND OF REJECTION TO BE REVIEWED ON APPEAL

- I. Whether the method for cleaning air as defined in claims 53, 54, 56-58, 60, 66, and 67 is properly rejected under 35 USC 102(e) as being anticipated by or, in the alternative, under 35 USC 103(a) as obvious over the anti-fog element disclosed in Komatsu et al. (US 5,854,708)?
- II. Whether the method for cleaning air as defined in claims 55, 59, and 61-65 is properly rejected under 35 USC 103(a) as unpatentable over the anti-fog element of Komatsu?

ARGUMENT

I. Reference Applied In the Rejections

Komatsu et al. (US 2006/0158026) With reference to his Figs. 1A, 1B, 4, and 6-14 Komatsu discloses an anti-fog element comprising a transparent substrate 10, a transparent photocatalyzer film / layer 18 disposed on one surface of the substrate, and a transparent porous inorganic oxide film / layer 12 disposed on a surface of the photocatalyzer film / layer 18 opposite to the substrate. An example of a material for the photocatalyzer film is TiO_2 . (Komatsu. at col. 2, lines 40-44.) An example of a material for the inorganic oxide film is silica or SiO_2 . (Id. at col. 2, lines 33-39.) Another, alternative example of a material for the inorganic oxide film is alumina or Al_2O_3 (Id.).

Komatsu expressly discusses that the transparent porous inorganic is formed on the film of the photocatalyzer and has a surface exhibiting a hydrophilic property so that organic matters etc. deposited in openings of the porous inorganic oxide film are dissolved and removed by a photocatalytic reaction caused by light excitation of the photocatalyzer film whereby the anti-fog property of the anti-fog element can be maintained over a long period of time. (Komatsu abstract). In the embodiment depicted in his Fig. 1, the pores / openings 20 of the porous inorganic oxide film 12 reach to the surface of the photocatalyzer film 18, while in the embodiment depicted in his Fig. 4, the pores / openings 20 of the porous inorganic oxide film 12 extend only partially into the film 12 without reaching to the surface of the photocatalyzer film. Thus, the anti-fog element is comprised of two films or layers, with one provided on a surface of the other: an inner photocatalyzer film, and an outer inorganic oxide film on the photocatalyzer film. (Id.)

II. The Grounds of Rejections

Issue I. The Examiner's position is set forth at item 2 on pages 2-3 of the final Office Action. It is essentially the Examiner's position: that use of Komatsu's anti-fog element would inherently clean contaminants from air; such anti-fog element includes a single surface layer containing TiO_2 , SiO_2 , and Al_2O_3 as the claimed components (i) – (iii) in close proximity with no intervening layers or components; such anti-fog element meets the characteristics defined in claims 54, 56, 59, 60, 67; and the Examiner has reason to believe that the functional

characteristics of the composite material used in the claimed method are inherently met by Komatsu's anti-fog element, whereby the Examiner asserts that he has shifted the burden of proving otherwise to the applicant.

Issue II. The Examiner's position is set forth at item 4 on pages 4-5 of the final Office Action. It is essentially the Examiner's position that:

while Komatsu fails to disclose particles having a diameter of 0.005 – 0.5 microns, it would have been obvious to persons of ordinary skill in the art at the time of the invention to use such size particles in the photocatalyst of Komatsu given his disclosed film thickness of 1000 angstroms;

while Komatsu does not disclose a ratio c/d of about 0.00001 – 0.05 as set forth in claim 59, it would have been obvious to persons of ordinary skill in the art at the time of the invention to use such a ratio in Komatsu anti-fog element because his disclosed embodiment involving titania of 2000 angstroms film thickness and inorganic oxide film thickness of 150 angstroms would have motivated the ordinary artisan to determine an optimum ratio through routine experimentation, and such optimum ratio falls in the claimed range; and

Komatsu discloses a film of SiO₂ on rectangular substrates, whereas applicant's preferred binder is SiO₂, which would motivate the ordinary artisan to form a glaze or a paint on a tile to make the film be exposed to light, satisfying the requirements of claims 61-64.

Relative to Both Issues I, II The Examiner provides a "Response to Arguments" set forth at item 5 on pages 5-6 of the final Office Action in which he briefly responds to some of applicant's arguments set forth in the Amendment of 20 February 2008. The Examiner's responses are essentially as follows:

- a) Regarding applicant's argument that Komatsu's anti-fog element *includes two films or layers*, contrary to the claimed invention in which the three or more components are all situated within a *single surface layer* such that all of the components are in close proximity to one another within the single surface layer, the Examiner finds such argument unpersuasive because applicant's specification also describes discrete layers and sols at pages 25-26;
- b) Regarding applicant's argument "that Komatsu does not disclose using a *mixture of SiO₂ and Al₂O₃*, nor does it disclose using any mixture of inorganic oxides for the inorganic oxide

film”, the Examiner finds such argument unpersuasive because both silica and alumina are layered together over the substrate of the claim and the prior art with no intervening layers or components such that at least some contact/combination of the two would occur;

c) Regarding applicant’s argument that Komatsu’s multi-layered structure *teaches away from the claimed invention*, and is evidence of the non-obviousness thereof, the Examiner finds such argument unpersuasive because the prior art does not teach away from the claimed single layer invention, since the prior art does not teach that such should be specifically avoided;

d) Regarding applicant’s argument that when used for cleaning air, as claimed, applicant’s single-layer structure is far superior to the laminate disclosed by Komatsu, ”, the Examiner states that such argument is unpersuasive. The fact that applicant has recognized another advantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious, while the Examiner also asserts that he has “reason to believe” in inherent characteristics of Komatsu’s element, whereby the burden of proof is shifted to the applicant to prove that the subject matter shown in the prior art does not possess the characteristics relied upon, pursuant to *In re Fitzgerald*, 205 USPQ 594 (CCPA 1980); and

e) Regarding applicant’s argument that the laminated, multiple-layer structure of Komatsu actually shields (masks) the beneficial photocatalytic material below a surface layer of silicon dioxide, whereas the claimed structure traps ambient organic material in a single exterior layer which contains photocatalytic material which is not masked by any cover layer, the Examiner finds such argument unpersuasive for the reasons discussed in a) – d).

Appellant’s Arguments

Appellant has carefully considered each of the Examiner’s rejections and responses presented in the final Office Action. However, appellant respectfully submits that each of present claims is patentably distinct over the Komatsu reference applied in the Examiner’s rejections, and that the Examiner has not established *prima facie* anticipation under 35 USC 102(e) or establish *prima facie* obviousness under 35 USC 103(a) of any of the present claims as discussed below.

Issue 1.

This Board should overrule and reverse the Examiner's rejection of claims 53, 54, 56-58, 60, 66, and 67 under 35 USC 102(c) as being anticipated by or, in the alternative, under 35 USC 103(a) as obvious over the anti-fog element disclosed in Komatsu because the Examiner has not established prima facie anticipation under 35 USC 102(c) or prima facie obviousness under 35 USC 103(a) of any of rejected claims.

Claim 53 is directed to a method for cleaning air. The method involves the use of a composite comprising a substrate and a single surface layer. The surface layer is hydrophilic and self-cleanable, and comprises at least three components. The three required components are: (1) a photocatalyst, (2) a component comprising a first metal oxide selected from a first Markush group, and (3) a component comprising a second metal oxide selected from a second Markush group. The above three components are all situated within the surface layer which is provided as a single surface layer, such that all of the components are in close proximity to one another within the single surface layer.

As explained in the background section of the present specification, the applicant has discovered / determined that while photocatalytic hydrophilifiable materials are conventionally used for converting nitrous oxides (NO_x) to nitric acid, etc., a problem of the conventional photocatalytic systems is that they permit NO₂ (an intermediate product in the photocatalytic reaction process) to escape without being fully reacted, and even where porous adsorbents such as activated carbon are used to prevent escape of the NO₂, this only provides marginal improvement for the conventional photocatalytic systems. See ¶¶ [0003] – [0005] of the publication.

Moreover, as also explained throughout the present specification, the invention of claim 53 (including the three components in close proximity in a single surface layer) overcomes the disadvantages of the conventional as explained at ¶¶ [0134]-[151] in conjunction with Figs. 1-7 and example 5 of Table 1, the disposition of a metal oxide component (ii) such as Al₂O₃ closely together with the photocatalyst such as TiO₂ in the surface layer permits the photocatalyst to

achieve a significantly enhanced effectiveness in removing contaminants such as NO_x, SO₂, and CO₂ from the air as compared to a surface layer not containing a metal oxide such as component (ii) disposed closely together with the photocatalyst; while as explained at ¶¶ [0221], and [0247]-[0257] of the published application, in conjunction with Table 5, the further addition of a metal oxide corresponding to the component (iii) closely together with the photocatalyst and the metal oxide component (ii) in the single surface layer significantly improves hydrophilicity of the surface layer and this provides a *synergistic advantage* as discussed at ¶ [0255] of the published application.

Directly contrary to the claimed invention involving at least three components in a *single surface layer*, Komatsu's anti-fog element is necessarily comprised of two films or layers, with one provided on a surface of the other: an inner photocatalyzer film 18, and an outer inorganic oxide film on the photocatalyzer film 12. In the multi-layer laminated structure of Komatsu, the photocatalyst film is actually shielded / masked by the outer layer of inorganic oxide, directly contrary to the claimed invention. Given this *indisputable distinction*, Komatsu does not anticipate the claimed invention under 35 USC 102(e) because his anti-fog element *does not include the claimed single surface layer*.

Moreover, given that Komatsu's disclosed and claimed invention necessarily requires the photocatalyst and the porous inorganic oxide to be disposed in two separate / distinct layers, the claimed invention is not obvious under 35 USC 103(a) in view of Komatsu. Based on Komatsu's actual disclosure, persons of ordinary skill in the art would find that: Komatsu *teaches away from the claimed invention*, and hence is evidence of the non-obviousness of the claimed invention; and the reference provides no motivation whatsoever for modifying his multi-layer element such that three components (i)-(iii) are provided in a single surface layer such as in the present claim 53, because such modification would involve *violation and destruction of Komatsu's invention*.

Apart from the fact that Komatsu fails to disclose a single surface layer comprising components (i) – (iii) as claimed, appellant submits that Komatsu also does not disclose using a *mixture of SiO₂ and Al₂O₃*, or any mixture of inorganic oxides for his inorganic oxide film 12.

He simply discloses use of these two compositions *in the alternative*. See Komatsu c. 2, 132-39, c. 5, 131-40, and his Examples 1-9.

Regarding the “Response to Arguments” presented in the final Office Action, appellant traverses each of such Responses because they are not legally or factually accurate.

Appellant respectfully traverses that the Examiner’s Responses a) and c) above because they do not accurately reflect the actual disclosure of the present specification or controlling law. While the present application may describe discrete layers and sols at ¶¶ [0130] – [0134] of the publication, the described sols and layers are *not disclosed as being used together in a single composite structure having multiple layers* as the Examiner asserts or implies. Rather, each of the formulated sols is disclosed as being individually used to form a single surface layer on a separate / different tile. See, for example, the plural term “tiles” which appears at ¶¶ [0133] – [0134] of the publication. Given the specific discussion at pages ¶¶ [0130] – [0134] of the publication, as well as the overall discussion of the invention throughout the present specification as *specifically involving a single surface layer*, it is *inaccurate and unreasonable* to interpret applicant’s disclosure as encompassing a multilayer structure.

Regarding the Examiner’s Response c) above, appellant respectfully traverses the same because it is not a reasonable or accurate application of the law. Based on the fact that Komatsu *requires a multi-layer structure for his anti-fog element*, persons of ordinary skill in the art would recognize that this is a teaching away from the presently claimed invention in which the components (i) – (iii) are disposed in *a single surface layer*. It is not a legal requirement that Komatsu expressly state that his element cannot involve a single layer structure in order to teach away from the claimed invention. Persons skilled in the art would clearly understand that the required multi-layer structure precludes a single layer structure even though Komatsu may not expressly state this.

Regarding the Examiner’s Response d) above, appellant respectfully traverses the same because the Examiner’s position is *not objectively reasonable* given the facts of the present matter, which are not at all like the facts in *In re Fitzgerald*. Here, the Examiner is asserting an incorrect / mistaken interpretation of applicant’s disclosure, i.e., applicant does not disclose a multi-layer structure as the Examiner is asserting or implying. Moreover, from an objective point of view, there is a very significant structural distinction between the claimed invention involving a *single surface layer* with the three components (i) – (iii) and Komatsu’s anti-fog

element in which an inorganic film/layer is deposited over a photocatalytic layer in a *multi-layer structure*. This is especially so given the importance of the claimed feature in solving a problem of the prior art as discussed throughout the present specification.

Quite differently, in *In re Fitzgerald* the claimed fastener and the prior art fastener were either identical or only slightly different (both possessed the same utility, both employed the same crystallizable polymer nylon 11, and both had an adherent patch formed by melting and then cooling the polymer), and the court found the PTO's position on burden shifting to be *objectively reasonable* given the *indisputable similarity* of the claimed invention and the prior art. Here the claimed and prior art structures are *indisputably different as an objective matter*, i.e., single layer v. multiple layers. Correspondingly, there is no objectively reasonable basis for the Examiner to believe that Komatsu's multi-layer structure inherently functions the same as the claimed invention, unlike the situation in *In re Fitzgerald*. Correspondingly, the Examiner cannot properly shift the burden of proof on this point to the applicant.

Dependent claim 54 further distinguishes over Komatsu because the claimed relationship of the components (i) and (ii) in the single surface layer ensures the chemical bond of the reactant or the intermediate to prevent the lowering of the catalytic reaction efficiency, and avoids lowering of the efficiency of the catalytic reaction. See ¶ [0020]. Komatsu fails to disclose or suggest a single surface layer meeting the claimed features.

Dependent claim 56 further distinguishes over Komatsu because he fails to disclose or suggest a single surface layer further comprising a fourth component (iv) as defined, whereas this added component (iv) in the single surface layer in close proximity with the components (i) –(iii) advantageously supplements the antimicrobial activity of the surface layer, even in situations where the surface layer may be somewhat shielded from light. See, for example the 3rd example discussed in ¶¶ [0177] – [0180] and Figs. 10-14 of the publication.

Dependent claim 57 further distinguishes over Komatsu because he fails to disclose or suggest a single surface layer further comprising at least one metal selected from the group consisting of silver, copper, palladium, iron, nickel, chromium, cobalt, platinum, gold, rhodium, and ruthenium, whereas this feature advantageously: improves the hydrophilicity of the surface

layer for enhanced effectiveness in removing contaminants; improves antimicrobial activity, and the metal can be advantageously supported on titanium dioxide by the reduction potential (supporting by reduction). See the 10th embodiment of the invention as discussed in ¶¶ [0031], [0180], [0181], [0214] of the publication.

Dependent claim 58 further distinguishes over Komatsu because he fails to disclose or suggest a single surface layer further comprising at least one metal selected from the group consisting of lithium, calcium, magnesium, and aluminum in an amount effective for improving the hydrophilicity. See ¶¶ [0031], [0181] of the publication.

Dependent claim 60 further distinguishes over Komatsu because he fails to disclose or suggest a single surface layer meeting the requirements (1) and (2), whereas when the thickness of the surface layer is not less than about 0.01 microns, the layer (surface layer) is not too thin and is advantageous in that the contact angle of the surface layer can be reduced and the material can exhibit high antifouling effect and can advantageously prevent the separation of the surface layer (layer separation). Further, silver ions in the silver nitrate solution deposited on the surface layer are reduced and precipitated to develop a color, as a result of receipt of excited electrons from the photocatalyst in the excitation upon exposure to ultraviolet light. Therefore, a color difference ΔE is observed between before ultraviolet irradiation and after ultraviolet irradiation of the surface layer. The more excited electrons produced, the larger the color difference ΔE . The amount of the excited electron produced is a factor that governs the photoactivity of the photocatalyst. This enables the photocatalytic activity to be evaluated by using the color difference ΔE . The excited electrons of the photocatalyst produce active oxygen species, such as hydroxy radical, in the air. Therefore, the higher the photocatalytic activity, that is, the larger the color difference ΔE , the greater the amount of the active oxygen species, such as hydroxy radical. See ¶¶ [0042] - [0044] of the publication

Dependent claim 66 further distinguishes over Komatsu because he fails to disclose or suggest a single surface layer further comprising an antimicrobial metal or a metal compound which is anchored on the surface of the surface layer, whereas this feature supplements the antimicrobial activity of the photocatalyst can be supplemented. See ¶¶ [0055] of the publication.

Dependent claim 67 further distinguishes over Komatsu because he fails to disclose or suggest a single surface layer in which the components (i), (ii) and (iii) are all substantially intimately mixed and dispersed in the single surface layer. See paragraphs [00126] - [0132], [0190], [0196], [0244] of the publication. This close proximity of components (i) – (iii) is believed to provide superior functionality as used in applicant’s claimed method, as extensively discussed throughout the original application.

Based on the foregoing, appellant respectfully submits that the Examiner has not established prima facie anticipation under 35 USC 102(e) or prima facie obviousness under 35 USC 103(a) of any of claims 53, 54, 56-58, 60, 66, and 67 under 35 USC 102(e) as being anticipated by or, in the alternative, under 35 USC 103(a) as obvious over the anti-fog element disclosed in Komatsu, and accordingly it is respectfully requested that the rejection be overturned.

Issue II

This Board should overrule and reverse the Examiner’s rejection of claims 55, 59 and 61-65 as being allegedly unpatentable under 35 USC 103(a) as being obvious over the anti-fog element disclosed in Komatsu because the Examiner has not established prima facie obviousness under 35 USC 103(a) of any of rejected claims. The arguments discussed above in relation to claims 53 and 56 also apply to the rejection of claims 55, 59 and 61-65. Additional arguments regarding the merits of these dependent claims are set forth below.

Dependent claim 55 further distinguishes over Komatsu because the claimed relationship of the components (i) and (ii) in the single surface layer permits the regulation of the particle diameter to be advantageously carried out by means of an existing grinding device, such as a ball mill, or by the sol-gel process, whereby there is no significant difference in particle diameter between the photocatalyst and the other compound, particles of the photocatalyst and particles of the other compound having diameters similar to those of the particles of the photocatalyst approach each other, and the other reactant or intermediate chemically bonded to the other compound can approach the photocatalyst. This advantageously ensures the opportunity for the catalytic reaction to proceed, realizing improved efficiency. See ¶ [0022]. Komatsu fails to disclose or

suggest a single surface layer meeting the claimed features.

Dependent claim 59 further distinguishes over Komatsu because he fails to disclose or suggest a single surface layer including components (i)-(iv), and in which in which components (iv) and (i) satisfy the claimed ratio c/d of about 0.00001 to about 0.05, whereas these features assure that there is no possibility that the amount of the metal is too small to exhibit synergistic antimicrobial activity, and that there is no possibility that the amount of the metal is excessive and adversely affects the catalytic reaction of the photocatalyst. See ¶ [0031] of the publication.

Dependent claim 61 further distinguishes over Komatsu because he fails to disclose or suggest a composite material having a binder which is interposed between the substrate and the single surface layer including the components (i) – (iii). The Examiner's reference to Komatsu's teaching of SiO₂ is misplaced because this material is used as Komatsu exterior inorganic oxide layer 12 which covers his photocatalyst layer 18. The material is not used as a binder between a substrate and a single surface layer in Komatsu.

Dependent claim 62 further distinguishes over Komatsu because he fails to disclose or suggest a binder which is polymerizable or meltable below a temperature at which the substrate is deformed, whereas such feature prevents unfavorable phenomena, such as excessive embedding of the photocatalyst formulation, the creation of irregular surface, or creation of pinholes, as well as damage to the substrate. See ¶¶ [0069], [0070] of the publication.

Dependent claim 63 further distinguishes over Komatsu because he fails to disclose or suggest a binder in the form of a glaze or a paint, whereas such a binder is very advantageous for easily applying the single surface layer to various substrates for cleaning air. . See ¶¶ [0171], [0246], [0268] of the publication.

Dependent claim 64 further distinguishes over Komatsu because he fails to disclose or suggest a substrate which is a tile, but instead he discloses use of a transparent substrate. See ¶¶ [0171], [0246], [0268] of the publication.

Dependent claim 65 further distinguishes over Komatsu because he fails to disclose or suggest a substrate which is an earthenware, a wood, a calcium silicate material, concrete, a cement board, a cement extruded board, a plaster board, or an autoclave light-weight concrete board. The ability to use the discussed substrates greatly expands the convenience of the claimed method for cleaning air. See ¶¶ [0171], [0246], [0268] of the publication.

Based on the foregoing, appellant respectfully submits that the that the Examiner has not established prima facie obviousness under 35 USC 103(a) of any of claims 55, 59, and 61- 65 over the anti-fog element disclosed in Komatsu, and accordingly it is respectfully requested that the rejection be overturned.

CONCLUSION

Based on all the foregoing, appellant respectfully submits that the Examiner's rejections in the final Office Action are in error, and a reversal of same is respectfully requested. Appellant encloses herewith a Claims Appendix including a copy of claims 53-67 on appeal, an Evidence Appendix confirming that there is None, and a Related Proceedings Appendix confirming that there are None.

A fee of \$540.00 for filing an Appeal Brief is being concurrently paid online via EFS-Web.

Favorable consideration and reversal of the final rejection are earnestly solicited.

Respectfully submitted,



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CERTIFICATE OF ELECTRONIC TRANSMISSION

I hereby certify that this correspondence is being electronically transmitted, via EFS-Web, to the United States Patent and Trademark Office, on February 9, 2009.



CLAIMS APPENDIX

Claim 53. A method for cleaning air, comprising the steps of:

contacting air with the surface of a composite material which is exposed to light; and
contacting the surface of the composite material with water, said composite material
comprising at least a substrate and a surface layer, said surface layer being hydrophilic and self-
cleanable, said surface layer comprising three components comprising:

a component (i) comprising a photocatalyst which functions as a catalyst upon exposure to
light;

a component (ii) comprising at least one metal oxide selected from the group consisting of
 Al_2O_3 , ZnO , SrO , BaO , MgO , CaO , Rb_2O , Na_2O , K_2O , and P_2O_5 ; and

a component (iii) comprising at least one metal oxide selected from the group consisting of
 SiO_2 , ZrO_2 , GeO_2 , and ThO_2 ;

wherein components (i), (ii) and (iii) are all situated within said surface layer which is
provided as a single surface layer, such that all of said components are in close proximity to one
another within the single surface layer.

Claim 54. A method according to claim 53, wherein the composite material satisfies $a/(a+b)$ of about
0.0001 to about 0.8, wherein a represents the weight of the metal oxide as the component (ii) and b
represents the weight of the photocatalyst as the component (i).

Claim 55. A method according to claim 53, wherein the photocatalyst as the
component (i) and the metal oxide as the component (ii) are contained in the form of particles having
a diameter of about 0.005 to about 0.5 microns.

Claim 56. A method according to claim 53, wherein the composite material further comprises a component (iv), in said surface layer, comprising at least one antimicrobial metal selected from the group consisting of zinc, silver, and copper, and wherein the antimicrobial metal as the component (iv) is supported on the photocatalyst as the component (i).

Claim 57. A method according to claim 53, wherein the surface layer further comprises at least one metal selected from the group consisting of silver, copper, palladium, iron, nickel, chromium, cobalt, platinum, gold, rhodium, and ruthenium.

Claim 58. A method according to claim 53, wherein the surface layer further comprises at least one metal selected from the group consisting of lithium, calcium, magnesium, and aluminum in an amount effective for improving the hydrophilicity.

Claim 59. A method according to claim 56, wherein the composite material satisfies c/d of about 0.00001 to about 0.05 wherein c represents the weight of the component (iv) and d represents the weight of the photocatalyst as the component (i).

Claim 60. A method according to claim 53, wherein the surface layer has a geometry satisfying any one of the following requirements (1) and (2):

(1) thickness of the surface layer is about 0.01 to about 3.0 microns; and

(2) difference in color ΔE of the surface layer between before ultraviolet irradiation and after ultraviolet irradiation of the surface layer, with a 1% silver nitrate solution deposited thereon, for 5 min at an ultraviolet intensity on the surface layer of 1.2 mW/cm^2 , is 1 to 50.

Claim 61. A method according to claim 53, wherein the composite material has a binder which is interposed between the substrate and the surface layer.

Claim 62. A method according to claim 61, wherein the binder is polymerizable or meltable below a temperature at which the substrate is deformed, to fix the surface layer onto the substrate.

Claim 63. A method according to claim 62, wherein the binder is a glaze or a paint.

Claim 64. A method according to claim 53, wherein the substrate is a tile.

Claim 65. A method according to claim 53, wherein the substrate is an earthenware, a wood, a calcium silicate material, concrete, a cement board, a cement extruded board, a plaster board, or an autoclave light-weight concrete board.

Claim 66. A method according to claim 53, wherein the composite material has an antimicrobial metal or a metal compound which is anchored on the surface of the surface layer.

Claim 67. The method of claim 53, wherein the components (i), (ii) and (iii) are all substantially intimately mixed and dispersed in the single surface layer.

EVIDENCE APPENDIX

None.

RELATED PROCEEDINGS APPENDIX

None.